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WHC-MR-0275

100-HR-1 Radiological Surveys

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Date Published
October 1991

Prepared for the U.S. Department of Energy
Office of Environmental Restoration and
Waste Management

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P.O. Box 1970
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Hanford Operations and Engineering Contractor for the
U.S. Department of Energy under Contract DE-AC06-87RL10930

Approved for Public Release

The content of this report is a factual and true representation of the ground surface radiological survey of the 100-HR-1 operable unit. The radiological data, statistical summaries and survey tracks were recorded and generated by a CHEMRAD Ultrasonic Ranging and Data System. The interpretations of the data are believed to be real and factual, based on verification with known bench marks and quality control checks of the recording software.

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100-HR-1 RADIOLOGICAL SURVEYS

SCOPE

This report summarizes the results of the radiological surveys conducted over the entire surface of the 100-HR-1 Operable Unit, Hanford Site, Richland, Washington (Figure 1). In addition, this report explains the survey methodology using the Ultrasonic Ranging and Data System (USRADS) automatic data recording equipment and describes the quality control techniques used to verify the data recording system.

The radiological survey of the 100-HR-1 Operable Unit, along with the background study, were conducted by 100 Areas Restoration and Remediation Health and Safety organization of the Westinghouse Hanford Company. The survey methodology was based on utilization of the Ultrasonic Ranging and Data System (USRADS) for automated recording of the gross gamma radiation levels of the surface soil.

PROCEDURES

The radiological surveys were conducted following the procedures contained in the Heath Physics Procedures Manual, (WHC-UP-0692.A); in particular; Section 1.05, Ultrasonic Ranging and Data System (USRADS): Connecting the Equipment, Rev. 0; Section 1.06, Ultrasonic Ranging and Data System (USRADS): Equipment Setup, Rev. 0; Section 1.07, Ultrasonic Ranging and Data System (USRADS): System Calibration, Rev. 0 and; Section 1.08, Ultrasonic Ranging and Data System (USRADS): Performing the Survey, Rev. 0.

The radiological surveys were conducted using a digital count rate meter with a sodium iodide detector connected to a CHEMRAD Tennessee Corp. Series 2000 USRADS. The count rate meter was set for gross counting, i.e., window "out". The window setting allows detection of low, intermediate and high energy photons. The USRADS equipment is used to record the detector readings verses the location of the readings, generate a map of the survey area and save the data on computer storage mediums.

LOW BACKGROUND SITE

Introduction

The Low Background survey was conducted to establish baseline radiological background conditions in a designated test plot adjacent to the 100-H Area. The radiological data collected during this survey is considered representative of the undestrubed soil surfaces in the 100 Areas of the Hanford Site. The survey was conducted on April 10, 15 and 16, 1991.

Location

The Low Background test plot is located in the 600 Area, between the 100-D/DR and 100-H Areas, approximately 2,000 feet from the Columbia River. The site had been previously staked on 100 foot intersects oriented along a north-south axis. The total size of the background plot is 500 by 500 feet. Figure 2 illustrates the layout of the low background survey site.

Discussion

The survey was conducted using a Ludlum Model 2221 digital rate meter with a Ludlum Model 44-2, 1 by 1 inch sodium iodide detector. The Ludlum meter was coupled to the USRADS for the purpose of recording the data from the

output of the detector verses the location of the data within the survey area.

A total of six individual surveys were performed to completely cover the 250,000 square foot site. A total of 4,924 data point were collected within the survey site. A summary of the survey results can be found in Table 1. Except for survey LBSa, each survey was traversed on approximately 25 foot transects.

Table 1. Summary Radiological Data for Low Background Site.

SURVEY	AREA (SQ.FT)	DATA POINTS	MEAN (CPM)	SIGMA (CPM)
LBSa	40,000	635	1,477	210
LBSc	40,000	829	1,932	310
LBSd	60,000	1,055	2,203	209
LBSi	60,000	1,146	2,192	212
LBSj	20,000	656	2,085	218
LBSk	30,000	603	1,828	213
TOTAL	250,000	4,924		

The Low Background survey was also used to establish and refine the survey methodology used during the 100-HR-1 survey proper. This methodology was applied consistently throughout the 100-HR-1 radiological survey and consisted of walking each survey area at about 1 meter per second while maintaining the detector at about 6 inches from the soil surface.

As the surveyor traverses the survey area, the USRADS records the output data from the radiation detector verses the location of where in the survey area the data was detected - each second. Therefore, while the survey is in progress, a real-time map of the survey area is generated. When the survey is completed, the survey data set is saved on a computer disk. Figure 3 graphically represents the track of the survey across the Low Background Site.

The background count rate was established by averaging the mean count rate for each survey. Using the formula: $BKGD=\Sigma\bar{X}-6$, the average background count rate for the Low Background Site was calculated to be 1,951 cpm, say 1,950 cpm. The standard deviation for the average is calculated using the formula: $S_{\bar{x}}=\frac{\sqrt{(S_a^2+S_b^2+\ldots S_z^2)}}{n}$

Based on the formula above, the standard deviation is +/- 95 cpm.

One of the features of the USRADS is the ability to enter a "Threshold" setting upon initiating a survey. The threshold setting is a value that when exceeded, the data point plotted on the CPU monitor is highlighted. This feature alerts the CPU operator that the cpm data has exceeded the threshold, or preset value. For the purpose of conducting the 100-HR-1 RI/FS surface radiation survey, it was desired to establish a value for the threshold, where readings above the setting could be considered surface contamination. The threshold value established for the entire 100-HR-1 Site survey was twice the background count rate determined above, or 3,900 cpm. This value is practical base on the premiss that too low a setting would highlight normal fluctuations above the calculated mean, and too high a setting would cut off the low end of surface contamination that might be present.

100-HR-1 SITE

INTRODUCTION

The 100-HR-1 radiological survey field task consisted of two activities: characterization of the operable unit-specific background conditions, discussed above, and the radiological survey of the operable unit surface area.

The total surface area surveyed was approximately 105 acres. Within this area a total of 126,425 data points were collected. Each of these data points represent a gross gamma radiation reading along with the physical coordinates of the reading. A total of 127 individual survey were conducted in order to complete the 105 acres of surface area. Sections of the operable unit not surveyed include the area inside the 116-H-7 exclusion fence; the area within the Clear Well barrier fence; the 183-H Solar Basin and the river shore.

During the period when the 100-HR-1 radiation survey was conducted, the Columbia River was relatively high. Therefore, the portion of the 100-HR-1 operable unit below the river bank crest could not be effectively surveyed. It was decided that this area would be incorporated into the river shore survey and be performed at a later date.

LOCATION

Prior to initiating the radiological survey of the 100-HR-1 Operable Unit, a grid system was established so that the individual surveys could be controlled and tied together. The starting point of the site grid is a point on the perimeter road on the southwest corner of the operable unit. The coordinates of the starting point are W40290, N94900. From the starting point the grid was established on 200 foot intersects. Each 200 by 200 foot grid block is labeled with consecutive numbers. Figure 4 illustrates the 100-HR-1 grid and block numbering system.

DISCUSSION

METHODOLOGY

Each survey entailed setting up the USRADS equipment in a grid block; connecting the radiation survey meter to the USRADS Data Pack; calibrating the USRADS equipment and performing the survey. Calibration of the USRADS is performed prior to starting a survey. The purpose to the calibration sequence is to reestablish the positioning instrumentation after the equipment is moved to a new location.

Each grid block is traversed, generally in a north-south direction, on approximately 25 foot transects. The gamma detector was maintained about 6 inches from the soil surface by suspending the detector from a boom attached to the surveyors backpack. In this manner detector geometry remained relatively constant throughout the entire survey.

Radiation survey instruments were checked at the beginning of each day for the proper instrument response. This was accomplished by placing a Cs-137 Check Source next to the detector and observing the instrument's response to the source. Local background radiation checks were also performed. This involved taking three-one minute counts and calculating the average of the three counts.

INSTRUMENTATION

Gamma Detection Instrumentation:

Ludlum Model 2221 Digital Scaler/Rate Meter, Serial No. 75434
Ludlum Model 2221 Digital Scaler/Rate Meter, Serial No. 78156
Ludlum Model 2221 Digital Scaler/Rate Meter, Serial No. 81302

Copies of the manufacturer's calibration certificates and Pacific Northwest Laboratory's calibration data can be found in Appendix A.

Alpha Detection Instrumentation:

Bicron Surveyor, Portable Alpha Meter, PNL Pool No. 2331
Bicron Surveyor, Portable Alpha Meter, PNL Pool No. 2983
Bicron Surveyor, Portable Alpha Meter, PNL Pool No. 2211
Eberline Portable Alpha Counter, PAC-6B, PNL Pool No. 8017
Eberline Portable Alpha Counter, PAC-6B, PNL Pool No. 8122

These portable alpha meters are maintained and calibrated by the Pacific Northwest Laboratory Instrumentation Pool.

Beta-Gamma Detection Instrumentation:

Eberline, E-1408 Meter, w/P-11 GM Probe, S/N 1350/836
Eberline, E-1408 Meter, w/P-11 GM Probe, S/N 1914/1304

These portable beta-gamma count rate meters are maintained and calibrated by the Pacific Northwest Laboratory Instrumentation Pool.

SURVEY RESULTS

Table 2 summarizes the radiological survey data for each grid block, along with the soil sample analytical results. Figure 5 is a composite track map of the entire 100-HR-1 Operable Unit survey. Locations where the count rate is above the threshold setting of 3,900 cpm are identified with either, a "radiation", or a "gamma" (γ) symbol. The "radiation" symbol indicates the location of elevated readings outside of the three exclusion areas. The "gamma" symbol indicates the location of elevated readings inside the 105-H Reactor Building exclusion fence.

Of the 127 surveys conducted at the 100-HR-1 Site, 22 surveys recorded elevated readings. In only 10 of the 22 surveys could the elevated readings be verified and duplicated. The elevated readings in the remaining 12 surveys were caused by noise spikes introduced by loose or faulty cables connecting the gamma detector to the digital rate meter. This conclusion was reached by either retracing the survey path in order to duplicate the event, or surveying the location with hand-held GM and NaI instrumentation. In each of the 12 cases the initial elevated reading could not be duplicated.

Figure 6 is a track map of grid block 65 where two locations with elevated readings were detected. One location is north of Well H-4-14, along the Clear Well perimeter fence. The other location is east of Well H-4-14. The maximum reading for both locations approximately 5,000 cpm. These elevated readings may be associated with past discharges from Well H-4-14. Soil sample results from these two locations indicate concentrations of cobalt-60, cesium-137 and europium-152 above the background concentrations in the surrounding grid blocks (Table 2).

Figure 7 is a track map of the surveys conducted in grid blocks 121, 122 and 123. The survey conducted in grid block 121 identified elevated readings next to H-540 Marker, H-71-22. The maximum count rate observed was about 6,000 cpm. The survey conducted in grid block 122 was extended northward to include the portion of grid block 123 south of the 116-H-7 exclusion fence. Elevated readings along the fence were detected with maximum readings of approximately 7,000 cpm.

Figure 8 is a composite track map of the surveys conducted inside of the 105-H exclusion fence. Due to the high level of "shine" from the posted Radiation Areas, ground surface contamination could not be determined with the existing method of surveying. Soil samples from selected locations indicated only low concentrations of cobalt-60, cesium-137 and europium-152 in the soil.

Figure 9 is a 2-dimensional contour of the radiation levels, in counts per minute, inside of the 100-H exclusion fence. Figure 10 is a 3-dimensional representation of the radiation levels inside the 100-H exclusion fence. Figure 10 should be compared with Figure 8 in order to "see" the magnitude of the areas identified with a gamma symbol.

Eighty-five soil samples were collected within the 100-HR-1 Operable Unit. Soil sample locations are illustrated on Figure 11 and the results are listed in Table 2. The majority of the gamma spectroscopy results are less than the detection limits for the specific isotopes of interest. Cobalt-60, cesium-137 and europium-152 were positively identified in samples associated with ground surface contamination, however the concentrations of these isotopes are very low.

Gross alpha and beta analyses were also performed on each of the soil samples. the results of the alpha analyses show no alpha activity above the detection limits of the laboratory instrumentation, i.e., all results were less than 1 pCi/g. Gross beta results showed concentrations typical of the undisturbed soils in the Hanford 100 Areas, which is about 15 to 20 pCi/g. Sample SSG-65A had the highest concentration of total beta at 122 pCi/g. The ratio of beta to gamma in this sample is about 12 to 1.

Alpha measurements were conducted along the north and south boundaries of each grid block at 25 foot intervals. These surveys were performed by placing the portable alpha meter detector about 1 centimeter from the ground surface, allowing the meter's analog indicator to stabilize and recording the readings. Figure 12 illustrates the locations of the alpha measurements. All portable alpha meter readings were less than detectable.

Excluding the ten surveys with verified surface contamination or, gamma radiation fields, the average of the mean count rates for the remaining 117 surveys is 1,958 cpm. This is nearly identical to the background count rate determined prior to the start of the 100-HR-1 survey.

QUALITY CONTROL

The following method was developed as a means of checking the USRADS data recording system and to determine whether or not it is recording accurately the output data of the Ludlum detector. The comparison tests were conducted while performing actual surveys in the field at the 100-HR-1 Site.

Each comparison test consisted of collecting readings from the Ludlulm meter display at a known location within the survey area. The corresponding USRADS data, recorded at the same location, were retrieved from files generated from the survey data stored on the computer hard disk. The mean count rate from each data set is then compared.

The comparison method is based on the null hypothesis that assumes there is no difference between the sets of data. In other words, the difference between the two mean count rates is zero. Since the data displayed by the Ludlum meter and recorded by the USRADS is generated from the same detector, the two instruments can be viewed as two methods analyzing the same sample population. Therefore, the same sample population is displayed n_1 times by Analytical Method 1 (USRADS) and n_2 time by Analytical Method 2 (Ludlum meter).

If the test sample is rejected by the hypothesis, then there is justification to claim there is a difference between the two data sets. If the test sample is not rejected by the hypothesis, then there is a good probability that the difference between the two sets of data is caused by random variations.

Four comparison checks were performed within 18 different survey areas, for a total of 72 field tests. Each recording check was tested against the null hypothesis. The difference between the two means, d, is assumed to be normally distributed , with a mean of zero. The formula for calculating the difference between the two means is: $d=\overline{X_1}-\overline{X_2}$. The difference has two independent sources of variation. These variations are s_{x1} due to Analytical Method 1 and due to Analytical Method 2. The variance of d is then calculated as, $s_d^2=\frac{s_1^2}{n_1}+\frac{s_2^2}{n_2}$

The standard deviation, s_1, in this case the square root of the variance of d, can be multiplied by 2 in order to calculate the acceptance range at the 95% confidence level. If d falls within the range, it can be stated that there is no significant difference between the two methods at the chosen confidence level. If d falls outside of this range, it can be stated the difference is significant.

Table 3 lists the data for each test in each survey area. Column 1 identifies the grid block in which the tests were performed. Column 2 identifies the individual test conducted within the grid block. Column 3 and 4 list the mean count rate and standard deviation of the USRADS data for each test with the grid block. Column 5 and 6 list the mean count rate and standard deviation of the Ludlum meter data for each test within the grid block.

Column 7 lists the percent difference between the two mean count rates. the percent difference is a good indication of the error between the two sets of data. The average percent difference between the two count rates is less than 5 percent.

Column 8 lists the numerical difference between the two mean count rates and corresponds to d. Column 9 is the calculated standard deviation of d. Column 10 represents the acceptance range for d at the 95% confidence level. It is noted that 13 test are rejected by the null hypothesis at the one sigma level and 5 test are rejected at the two sigma level, or 95% confidence level.

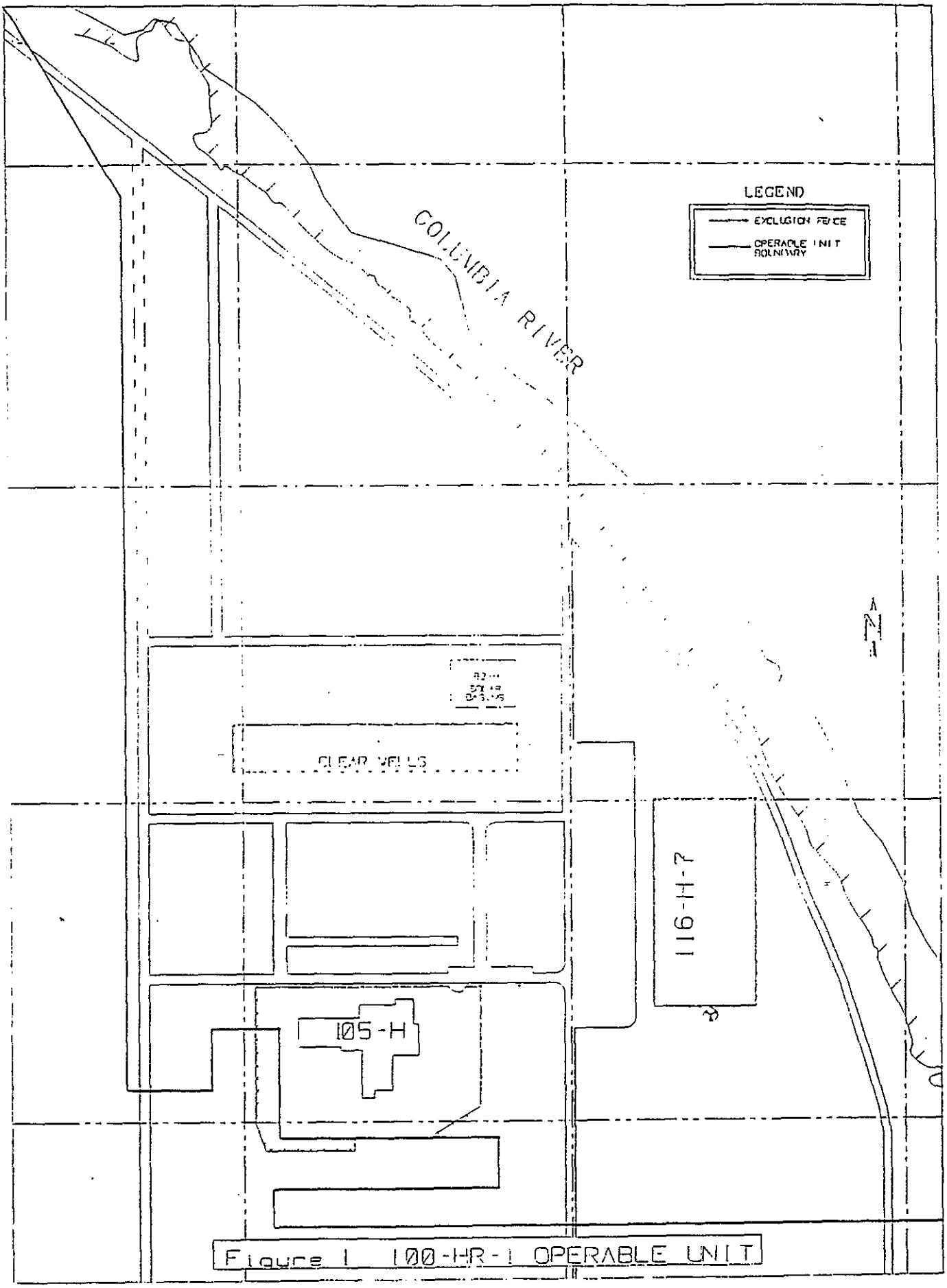

Figure 1 100-HR-1 OPERABLE UNIT

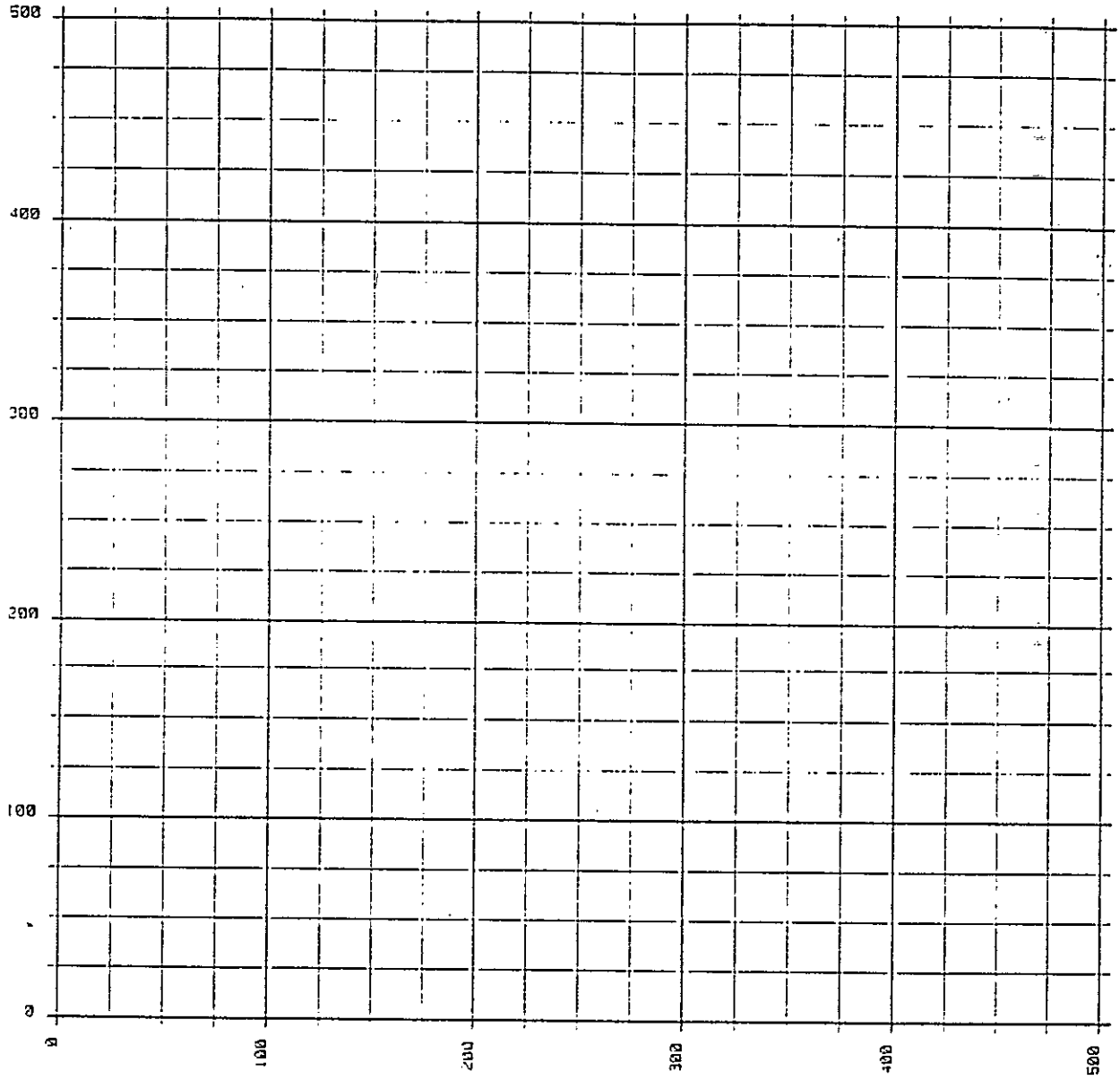

Figure 2. LOW BACKGROUND SITE GRID LAYOUT

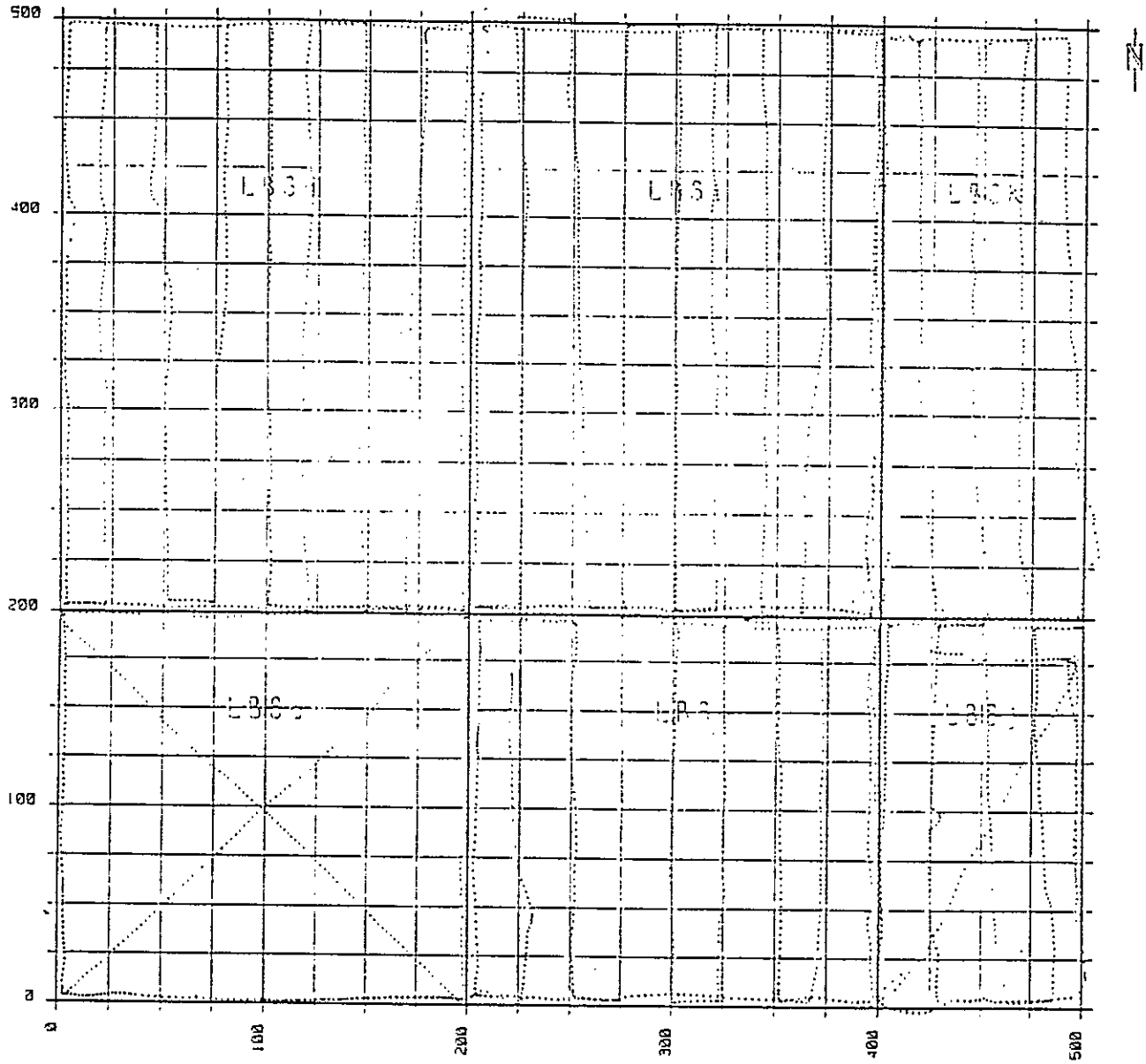

Figure 3. LOW BACKGROUND SITE USRADS SURVEY TRACK

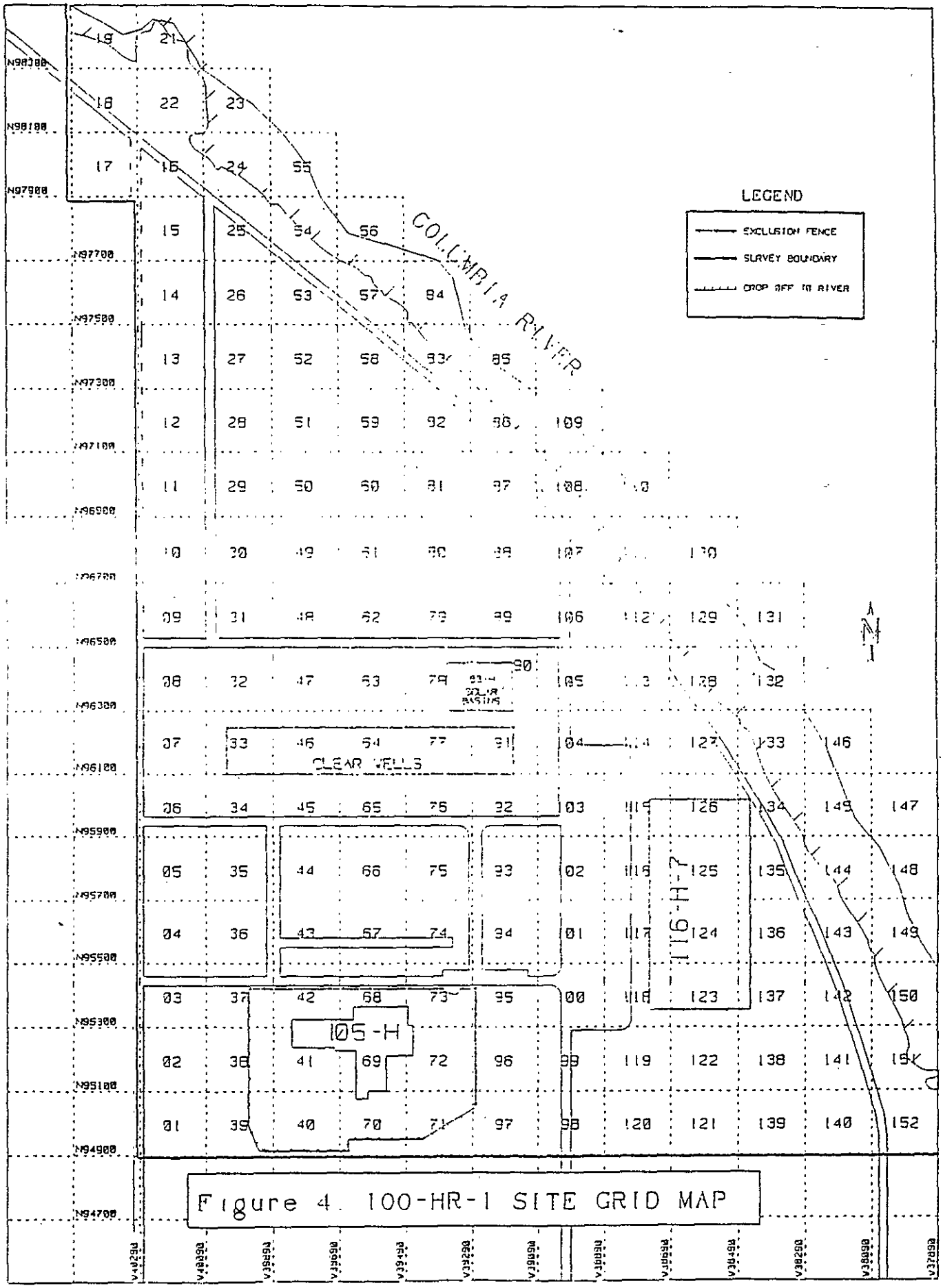

Figure 4. 100-HR-1 SITE GRID MAP

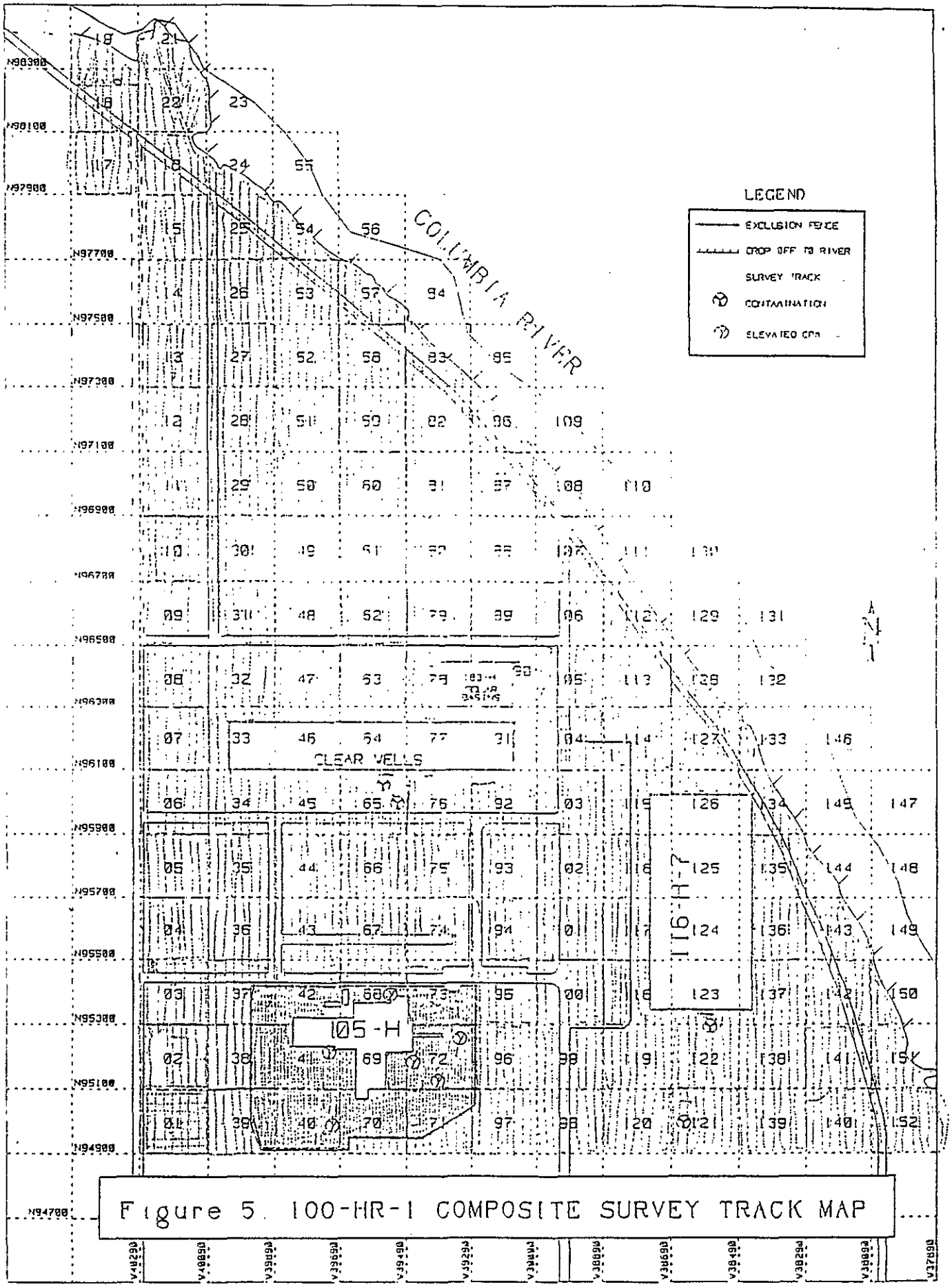

Figure 5. 100-HR-1 COMPOSITE SURVEY TRACK MAP

Table 2. 100-HR-1 Summary Data: Gamma Survey and Soil Sample Results (Cont'd)

GRID BLOCK #	DATA POINTS	MIN. CPM	MAX. CPM	MEAN CPM	STDDEV CPM	SOIL SAMPLE #	KE LAB #	ALPHA pCi/g	BETA pCi/g	Co-60 pCi/g	Cs-137 pCi/g	Eu-152 pCi/g
47	866	1320	2460	1880	204	SSG-47	501-91	<1.0	17.0	<0.1	<0.1	<0.3
48	890	1460	2700	1946	203							
49	758	1400	2860	2104	239	SSG-49	505-91	<1.0	10.9	<0.2	<0.2	<0.4
50	798	1260	2680	1859	224							
51	878	1380	2640	1900	212	SSG-51	504-91	<1.0	10.3	<0.1	<0.2	<0.2
52	739	1260	2700	1998	245							
53	782	1320	2500	1867	210							
54	549	1180	2420	1759	206	SSG-54	508-91	<1.0	14.3	<0.1	0.37	<0.2
55												
56												
57	1194	1000	2400	1645	200	SSG-57	554-91	<1.0	14.5	<0.2	<0.2	<0.4
58	751	980	2580	1797	227							
59	878	1260	2580	1837	210	SSG-59	569-91	<1.0	15.3	<0.2	<0.2	<0.6
60	857	1280	2920	1863	250							
61	583	1360	2860	1995	[illegible]	SSG-61	548-91	<1.0	9.8	<0.2	<0.2	<0.6
62	986	1300	2860	1945	243							
63	984	1340	2620	1866	194	SSG-63	567-91	<1.0	15.5	<0.2	<0.2	<0.3
64												
65*	1960	1080	4900	2386	722	SSG-65A	477-91	<1.0	22.2	0.7	0.2	4.3
						SSG-65B	478-91	<1.0	19.8	<0.2	1.4	1.3
66+	395	1120	7100	2922	512	SSG-66	532-91	<1.0	9.6	<0.2	<0.2	<0.4
67+	932	1440	5400	2032	359							
68	713	1340	2560	1996	185	SSG-68	563-91	<1.0	15.0	<0.2	<0.2	<0.4
68X*	552	980	5180	2063	440							
69X*	634	3020	233420	21173	41107							
70	318	1540	3060	2346	308	SSG-70A	557-91	<1.0	10.4	<0.2	0.3	<0.3
70X*	1479	1960	19600	3595	1867	SSG-70B	621-91	<1.0	12.2	<0.2	0.4	<0.4
71	545	1640	3100	2237	237	SSG-71A	556-91	<1.0	10.4	<0.2	<0.3	<0.6
71X*	1416	300	4200	2926	332	SSG-71B	622-91	<1.0	18.1	<0.1	0.6	<0.3
72X*	2848	580	41500	3773	4100	SSG-72XA	643-91	<1.0	8.1	1.0	1.0	8.0
						SSG-72XB	636-91	<1.0	11.7	<0.2	0.5	1.0
						SSG-72	559-91	<1.0	11.4	<0.2	<0.6	<0.4
73+	538	1400	4660	2055	324							
73X	1845	1320	3860	2316	328	SSG-73	561-91	<1.0	10.3	<0.2	0.5	<0.5
74+	717	1340	4080	2024	299	SSG-74	566-91	<1.0	15.5	<0.2	<0.2	<0.5
75+	856	1280	5140	1997	341	SSG-75A	642-91	<1.0	16.4	<0.2	<0.3	<0.5
						SSG-75B	633-91	<1.0	17.4	<0.2	<0.2	<0.6
76	1009	1300	3500	2067	341	SSG-76	572-91	<1.0	11.4	<0.2	1.5	1.8
77												
78	663	1140	2460	1843	214							
79	1074	1400	2660	1902	235	SSG-79	549-91	<1.0	16.6	<0.2	<0.2	<0.5
80	663	1420	2860	2086	274							
81	768	1320	2960	1857	245	SSG-81	558-91	<1.0	11.4	<0.2	<0.2	<0.6
82	915	1140	2460	1738	213	SSG-82	552-91	<1.0	12.9	<0.3	<0.3	<0.9
83	713	1080	2300	1661	207							
84												
85												
86	630	1080	2140	1609	178							
87	1066	1160	2300	1664	196	SSG-87	568-91	<1.0	22.8	<0.6	<0.6	<0.8
88	807	1140	2640	1988	248	SSG-88	553-91	<1.0	10.3	<0.3	<0.3	<0.7
89	1025	1300	2680	1906	243							

Table 2. 100-HR-1 Summary Data: Gamma Survey and Soil Samole Resuts (Cont'd)

GRID BLOCK #	DATA POINTS	MIN. CPM	MAX. CPM	MEAN CPM	STDDEV CPM	SOIL SAMPLE #	KE LAB #	ALPHA pCi/g	BETA pCi/g	Co-60 pCi/g	Cs-137 pCi/g	Eu-152 pCi/g
90												
91	597	1340	2660	1892	220							
92	1126	1360	2820	1958	214	SSG-92	560-91	<1.0	21.7	<0.2	2.1	3.3
93	859	1320	3200	1982	239							
94	1017	1240	9340	2044	490	SSG-94	564-91	<1.0	12.9	<0.2	<0.2	<0.5
95	964	1280	2620	1917	216							
96	852	1140	2660	1986	247	SSG-96	565-91	<1.0	16.1	<0.2	<0.3	<0.6
97	974	1500	3020	2120	236	SSG-97	573-91	<1.0	18.1	<0.2	<0.2	<0.6
98	867	1440	2700	2006	192							
99	828	1300	2660	1925	213	SSG-99	635-91	<1.0	10.7	<0.2	0.4	<0.4
100	946	1340	2560	1931	210							
101	1131	1300	2600	1951	208	SSG-101	624-91	<1.0	12.7	<0.3	<0.2	<0.6
102	1016	1100	2520	1913	213							
103	973	1200	2500	1842	194	SSG-103	616-91	<1.0	14.5	<0.2	<0.2	<0.4
104	1043	1340	2360	1845	195							
105	983	1280	2280	1805	181	SSG-105	640-91	<1.0	10.7	<0.2	0.2	<0.4
106	880	1160	2560	1904	213							
107	1061	1140	2440	1890	209	SSG-107	625-91	<1.0	7.6	<0.3	0.3	<0.6
108	613	1060	2340	1604	213							
109												
110												
111												
112	1103	1100	2250	1675	187	SSG-112	630-91	<1.0	18.3	<0.2	<0.2	<0.5
113	716	1260	2400	1768	199							
114	892	1240	2500	1809	192	SSG-114	614-91	<1.0	14.5	<0.2	0.3	<0.4
115	799	1200	2580	1921	206							
116	612	1560	2860	1987	220	SSG-116	623-91	<1.0	9.6	<0.2	0.5	<0.4
117	662	1340	2920	2016	250							
118	882	1420	3020	2046	253							
119	885	1440	2860	2084	228	SSG-119	626-91	<1.0	18.9	<0.2	<0.2	<0.5
120	715	1580	3120	2137	250	SSG-120	619-91	<1.0	18.9	<0.2	<0.2	<0.4
121*	1024	1680	6840	2611	629	SSG-121A	550-91	<1.0	28.0	<0.2	11.7	11.4
						SSG-121D	547-91	<1.0	31.1	<0.2	6.5	8.1
						SSG-121E	546-91	<1.0	16.1	<0.2	2.6	2.7
122*	1566	1500	6240	2502	641	SSG-122A	551-91	<1.0	22.3	<0.2	3.7	0.8
						SSG-122B	545-91	<1.0	19.2	3.4	2.0	2.3
						SSG-122C	555-91	<1.0	11.9	<0.3	3.4	<0.5
123												
124												
125												
126	522	1200	2340	1806	204	SSG-126	638-91	<1.0	15.3	<0.2	<0.2	<0.5
127	1154	1060	2460	1722	192							
128	599	1140	2120	1603	186	SSG-128	613-91	<1.0	21.7	<0.2	<0.2	<0.4
129												
130												
131												
132												
133	390	1180	2180	1688	195							
134	664	1080	2520	1786	228	SSG-134	641-91	<1.0	12.7	<0.2	1.2	1.0

Table 2. 100-HR-1 Summary Data: Gamma Survey and Soil Sample Results (Cont'd)

GRID BLOCK #	DATA POINTS	MIN. CPM	MAX. CPM	MEAN CPM	STDDEV CPM	SOIL SAMPLE #	KE LAB #	ALPHA pCi/g	BETA pCi/g	Co-60 pCi/g	Cs-137 pCi/g	Eu-152 pCi/g
135	963	1260	2580	1858	221	SSG-135	627-91	<1.0	9.6	<0.2	<0.2	<0.5
136	783	1340	2840	1984	256	SSG-136	639-91	<1.0	16.9	<0.2	<0.2	<0.5
137	584	1460	2820	2030	250	SSG-137	617-91	<1.0	19.2	<0.2	0.6	<0.4
138	791	1400	3300	2003	269	SSG-138	615-91	<1.0	21.7	<0.2	<0.2	<0.5
139	829	1480	3320	2186	331							
140	812	1740	3380	2429	303	SSG-140	631-91	<1.0	13.8	<0.2	<0.3	<0.7
141	1062	1320	2800	1986	232							
142	870	1340	3000	1958	227	SSG-142	620-91	<1.0	12.2	<1.7	<0.2	<0.6
143	874	1140	2980	1926	245	SSG-143	618-91	<1.0	9.6	<0.2	<0.2	<0.4
144												
145												
146												
147												
148												
149												
150	453	1580	2960	2426	223	SSG-150	634-91	<1.0	7.6	<0.2	1.4	<0.5
151	557	1400	3540	1973	204	SSG-151	629-91	<1.0	13.3	<0.2	1.5	2.0
152	1089	1300	2730	2019	203							
TOTAL	126425											
AVERAGE MEAN				1958								

* Elevated cpm attributed to noise spikes from detector cable.
\# Verified elevated cpm readings.

R1 TOTAL	15882
R2 TOTAL	18030
R3 TOTAL	27089
R4 TOTAL	40738
R5 TOTAL	24686

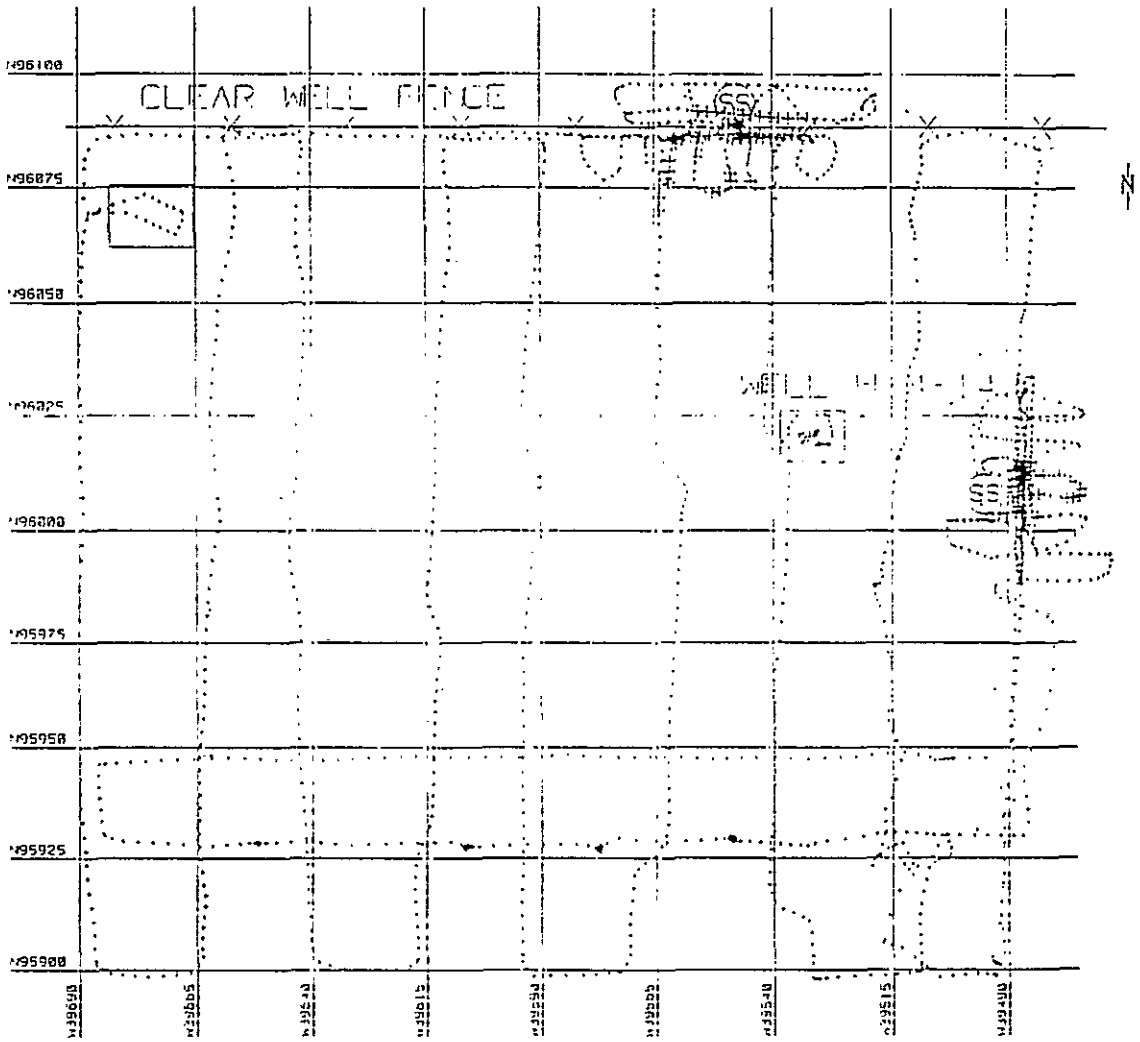

Figure 6 TRACK MAP OF USPADS SURVEY HR1G65A

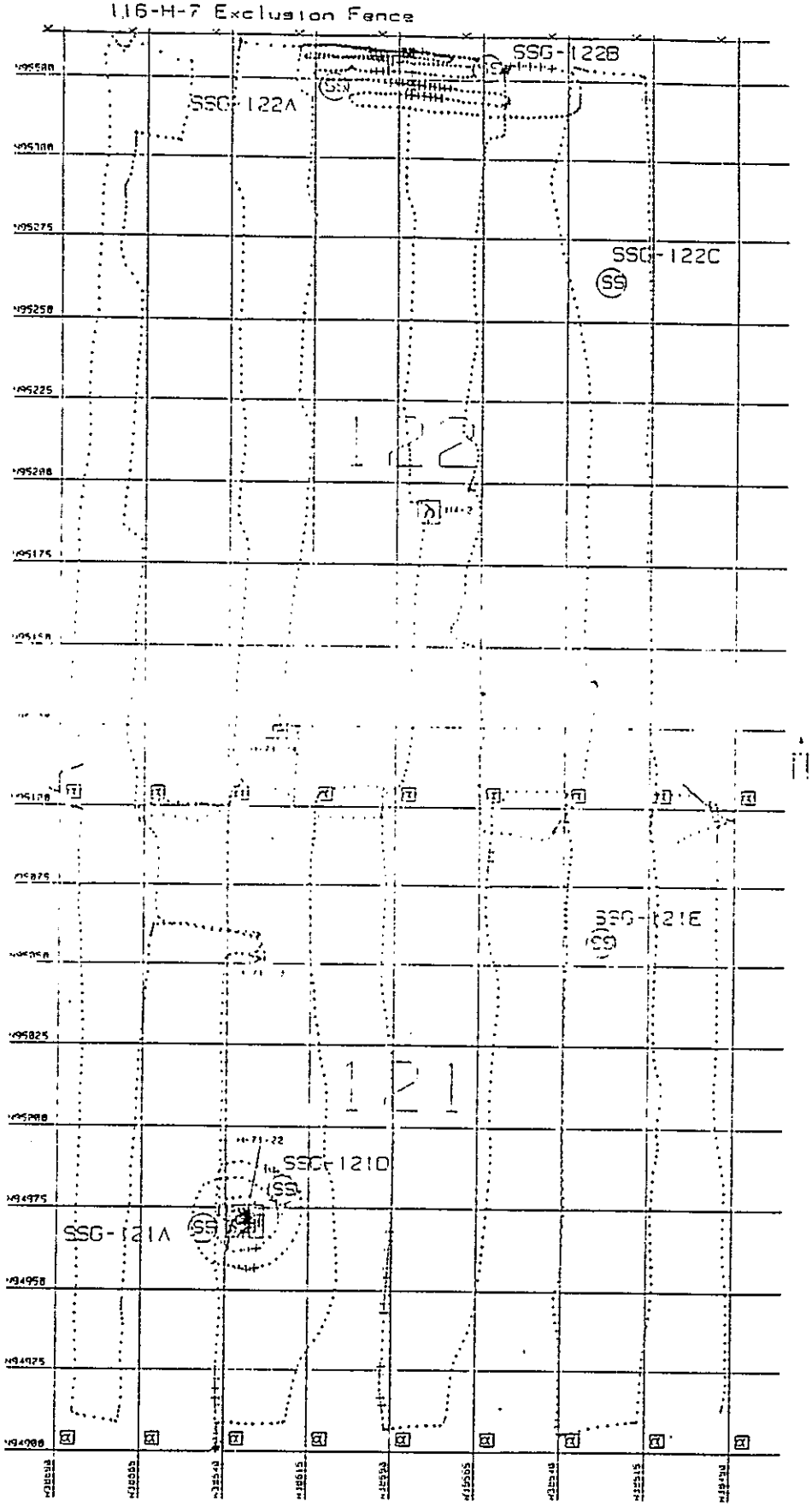

Figure 7. COMPOSITE TRACK MAP FOR USRADS SURVEYS HRIG121 AND HRIG122

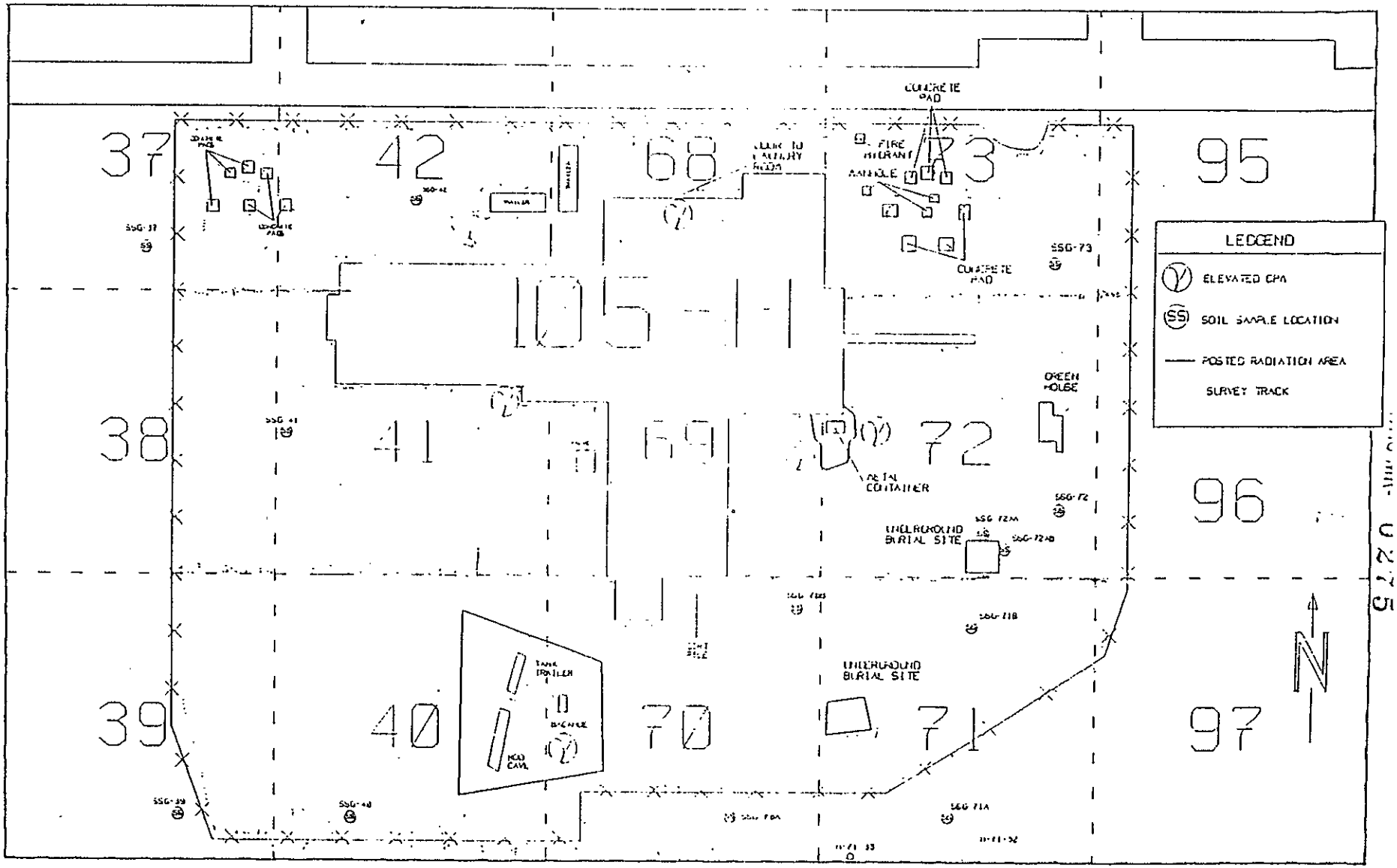

Figure 8. COMPOSITE TRACK MAP OF 105-H EXCLUSION AREA

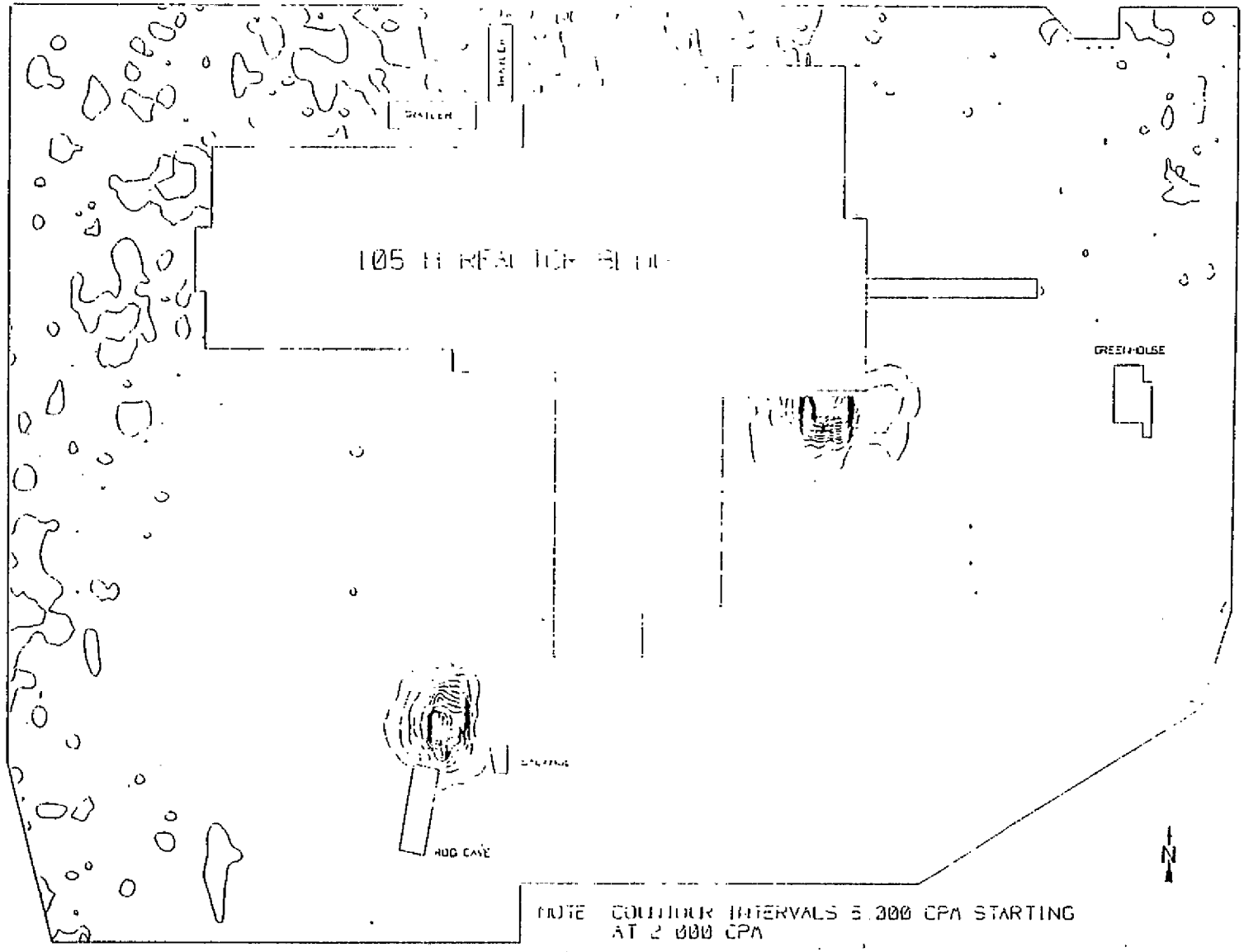

FIGURE 9. RADIATION CONTOUR IN CPM, INSIDE 105-H EXCLUSION AREA

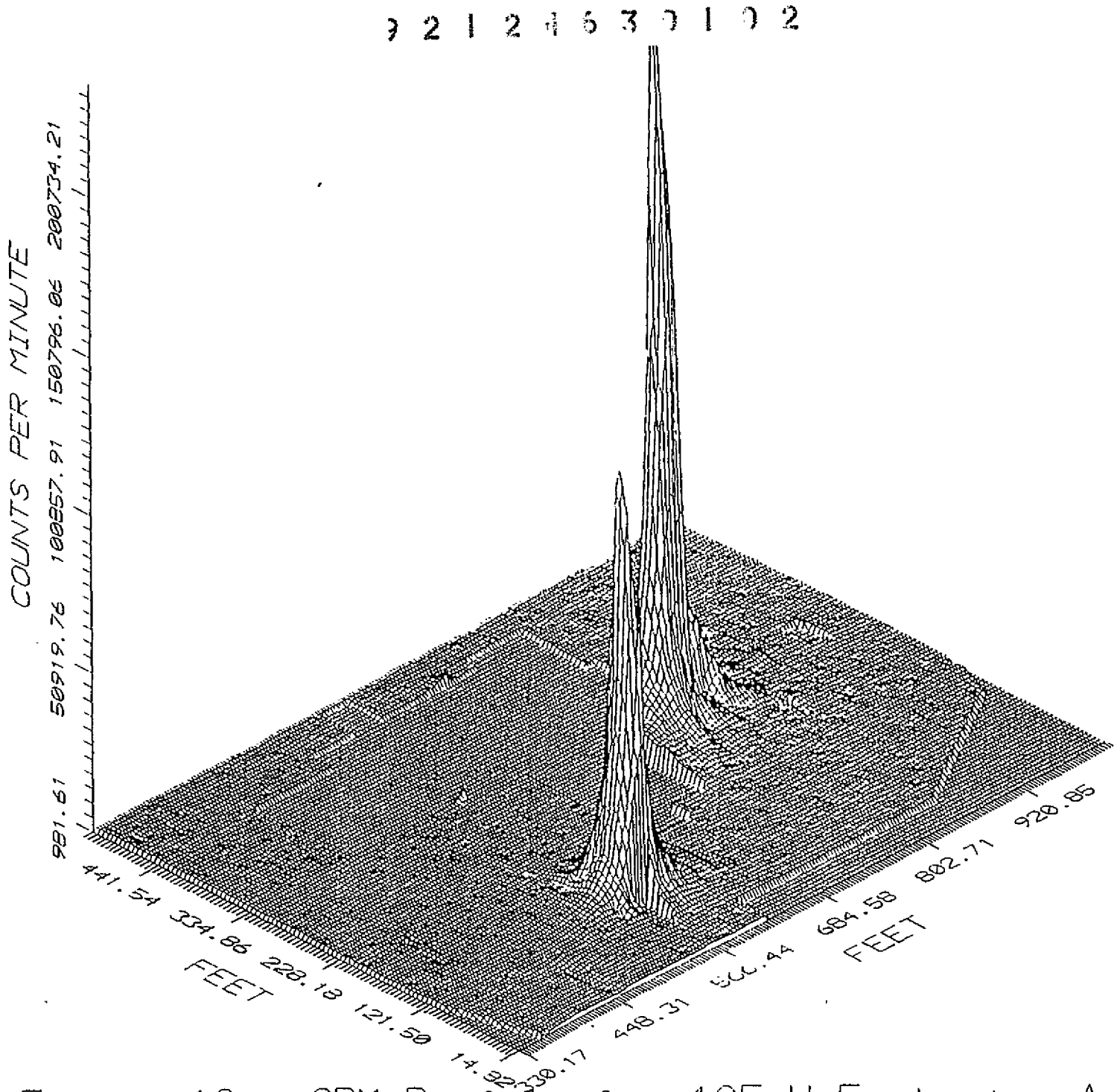

Figure 10. CPM Profile for 105-H Exclusion Area

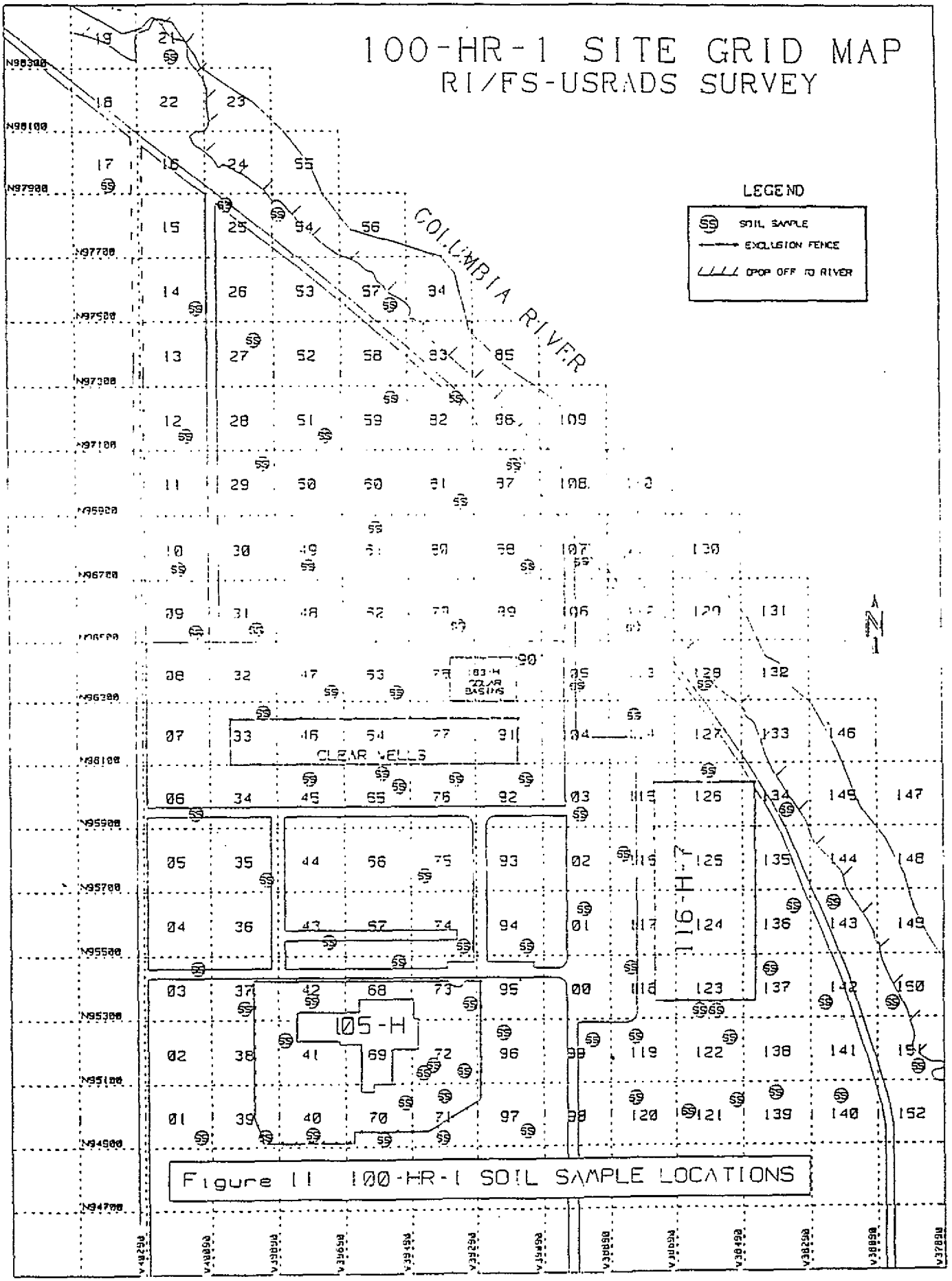

Figure 11 100-HR-1 SOIL SAMPLE LOCATIONS

Table 3. QC Summary Statistical Data for the 100-HR-1 Operable Unit Radiological Survey

GRID BLOCK	QC TEST	USRADS(X1) MEAN	USRADS(X1) SIGMA	LUDLUM(X2) MEAN	LUDLUM(X2) SIGMA	DELTA %	X1-X2	SDd	SDd@95%CL	
1	1	1546	167	1548	37	0.13	-2	39.1	78.3	
	2	1538	106	1521	46	1.11	17	27.8	55.6	
	3	1518	144	1485	61	2.17	33	37.5	75.1	
	4	1483	166	1553	65	4.51	-70	42.4	84.9	
2	1	1812	203	1803	46	0.50	9	47.7	95.3	
	2	1940	243	1823	74	6.03	117	59.2	118.3	
	3	1732	177	1749	66	0.97	-17	44.7	89.5	
	4	1848	158	1838	56	0.54	10	39.5	79.0	
3	1	1933	248	1866	45	3.47	67	57.3	114.5	
	2	1928	243	1917	50	0.57	11	56.6	113.2	
	3	1823	155	1755	39	3.73	68	36.3	73.6	
	4	1691	222	1709	73	1.05	-18	54.7	109.5	
4	1	1718	160	1756	37	2.16	-38	36.7	73.4	
	2	1823	168	1847	38	1.30	-24	38.5	77.0	
	3	1874	247	1839	73	1.87	35	57.3	115.6	
	4	1816	251	1730	99	1.43	26	60.3	120.7	
5	1	1756	148	1762	38	0.34	-6	34.2	68.3	
	2	1791	224	1827	80	1.97	-36	49.2	98.3	
	3	1660	22	1682	17	1.31	-22	32.2	64.5	
	4	1644	155	1697	66	3.12	-53	38.7	76.1	
6	1	1853	177	1829	58	1.30	24	41.6	83.3	
	2	1773	167	1800	53	1.50	-27	39.2	78.4	
	3	1675	139	1794	126	6.63	-119	52.7	105.3	*
	4	1850	211	1954	58	5.22	-4	48.3	97.3	
7	1	1761	171	1751	50	0.57	10	39.8	79.7	
	2	1684	160	1664	52	1.19	20	37.6	75.2	
	3	1792	177	1782	48	0.56	10	41.3	82.9	
	4	1775	135	1744	37	1.75	31	31.3	62.6	
8	1	1727	134	1752	33	1.43	-25	45.1	90.3	
	2	1695	197	1687	43	0.47	8	45.7	90.2	
	3	1731	127	1746	37	0.86	-15	29.6	59.2	
	4	1684	130	1721	33	2.15	-37	30.3	60.0	
9	1	1667	145	1692	56	1.48	-25	34.8	69.5	
	2	1876	282	1755	94	5.45	121	66.3	132.9	
	3	1546	108	1626	45	4.32	-80	26.2	52.3	*
	4	1682	205	1711	57	1.59	-29	47.6	95.2	
10	1	1798	260	1736	90	3.45	62	60.3	121.7	
	2	1737	192	1758	44	1.19	-21	44.0	88.1	
	3	1604	195	1727	98	7.12	-123	48.8	97.6	*
	4	1718	137	1638	62	4.66	80	33.6	67.3	*
14	1	1889	263	1955	176	3.38	-66	81.0	161.9	
	2	1955	180	1888	199	3.43	67	74.7	149.4	
	3	1827	298	1705	227	6.68	122	97.9	195.9	
	4	1887	223	1919	192	1.67	-32	78.6	157.1	
17	1	1834	144	1832	112	0.11	2	47.9	95.7	
	2	1801	101	1793	144	0.44	8	50.9	101.7	
	3	1786	193	1838	163	2.83	-52	67.2	134.5	
	4	1912	264	1956	119	2.25	-44	70.0	140.0	

Table 3. QC Summary Statistical Data for the 100-HR-1 Operable Unit Radiological Survey (Cont'd)

GRID BLOCK	QC TEST	USRADS(X1) MEAN	USRADS(X1) SIGMA	LUDLUM(X2) MEAN	LUDLUM(X2) SIGMA	DELTA %	X1-X2	SDd	SDd@95%CL	
39	1	2115	159	2040	61	3.55	75	40.4	80.9	
	2	2065	186	2091	62	1.24	-26	46.3	92.0	
	3	1997	176	2102	74	5.00	-105	45.8	91.5	*
	4	2402	140	2355	90	1.96	47	42.3	84.6	
40	1	5190	331	5230	369	-0.77	-40	138.2	276.4	
	2	3321	218	3458	235	-4.13	-137	88.3	177.7	
	3	2606	204	2564	202	1.61	42	78.5	157.0	
	4	3881	258	3695	252	4.79	186	98.4	196.8	
65	1	1948	179	1932	213	0.82	16	78.4	156.7	
	2	1838	130	1904	178	3.47	-66	63.4	126.7	
	3	1962	168	1926	159	1.83	36	62.8	125.5	
	4	1774	203	1874	191	5.34	-100	75.6	151.1	
37	1	1720	117	1729	161	-0.52	-9	57.2	114.5	
	2	1767	151	1716	233	2.89	51	81.3	162.5	
	3	1705	170	1735	178	-1.76	-30	67.9	135.8	
	4	1655	207	1787	169	-7.38	-132	58.6	117.1	*
102	1	1869	206	1905	194	-1.93	-36	76.7	153.4	
	2	1963	181	1964	141	-0.05	-1	60.2	120.4	
	3	1845	254	1910	237	-3.52	-65	73.2	146.4	
	4	1942	227	1905	195	1.81	37	79.8	159.7	
122	1	2104	205	2098	203	0.29	6	78.8	157.8	
	2	2561	212	2632	238	-2.77	-71	88.8	177.3	
	3	2647	290	2674	239	-1.02	-27	98.8	197.7	
	4	2172	163	2180	189	-0.37	-8	70.7	141.4	

* Test rejected by null hypothesis